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Griffee

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[54] **DUAL BAND COLLINEAR DIPOLE ANTENNA**

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[52] **U.S. Cl.** **343/792**; 343/801; 343/821

[58] **Field of Search** 343/790–792, 343/801, 807, 808, 821

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,727,231 4/1973 Galloway et al. 343/813

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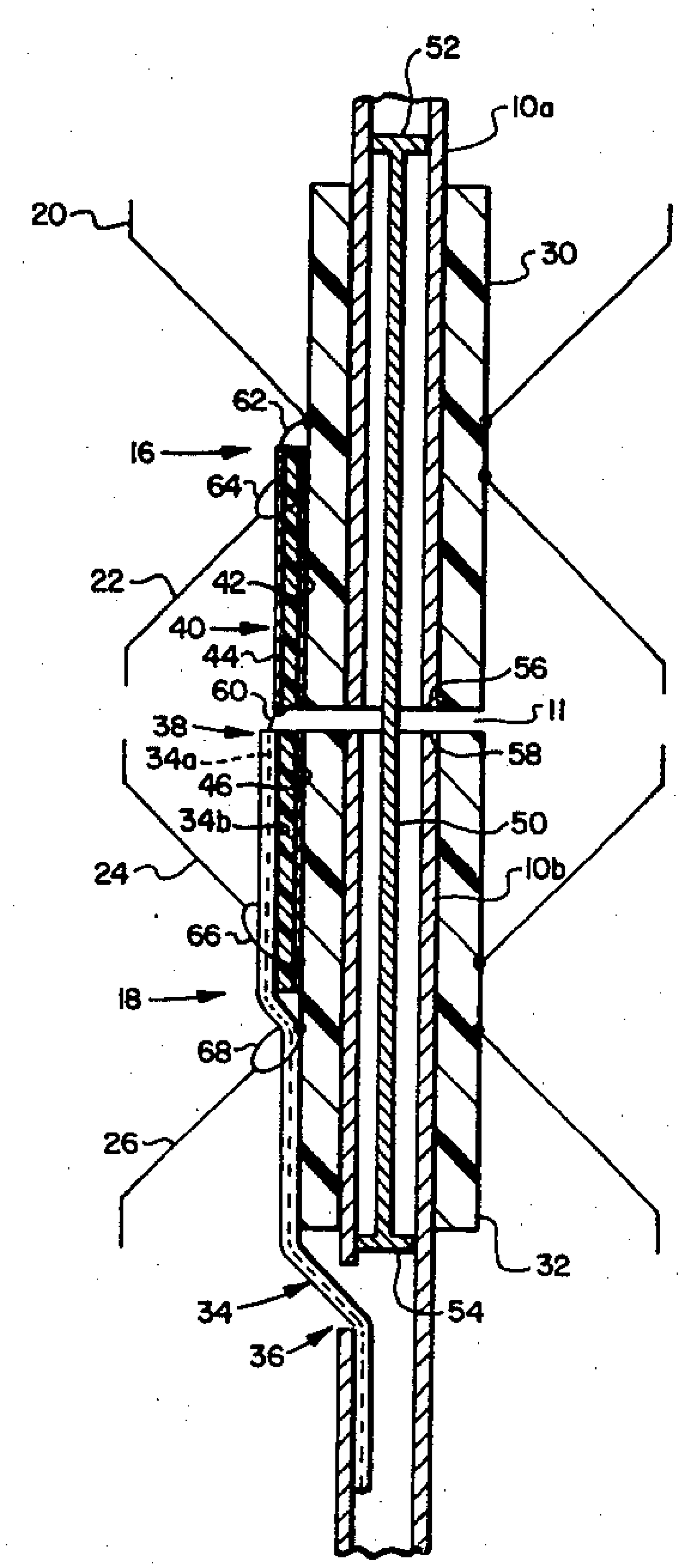
[57] **ABSTRACT**

A collinear dual dipole antenna is split into two sections which are connected by a central conductor extending in spaced parallel relation within hollow support mast sections, and forming an effective transmission line providing RF continuity at a high band frequency f, and discontinuity at a low band frequency ½ f. The configuration provides a dual band antenna operating in either band from a single source without filtering and without modification of the antenna. In the high frequency band, the antenna operates as a dual dipole array. In the low frequency band, the antenna operates as a single dipole array with each mast section and its respective dipole acting as half of the single dipole array.

8 Claims, 2 Drawing Figures



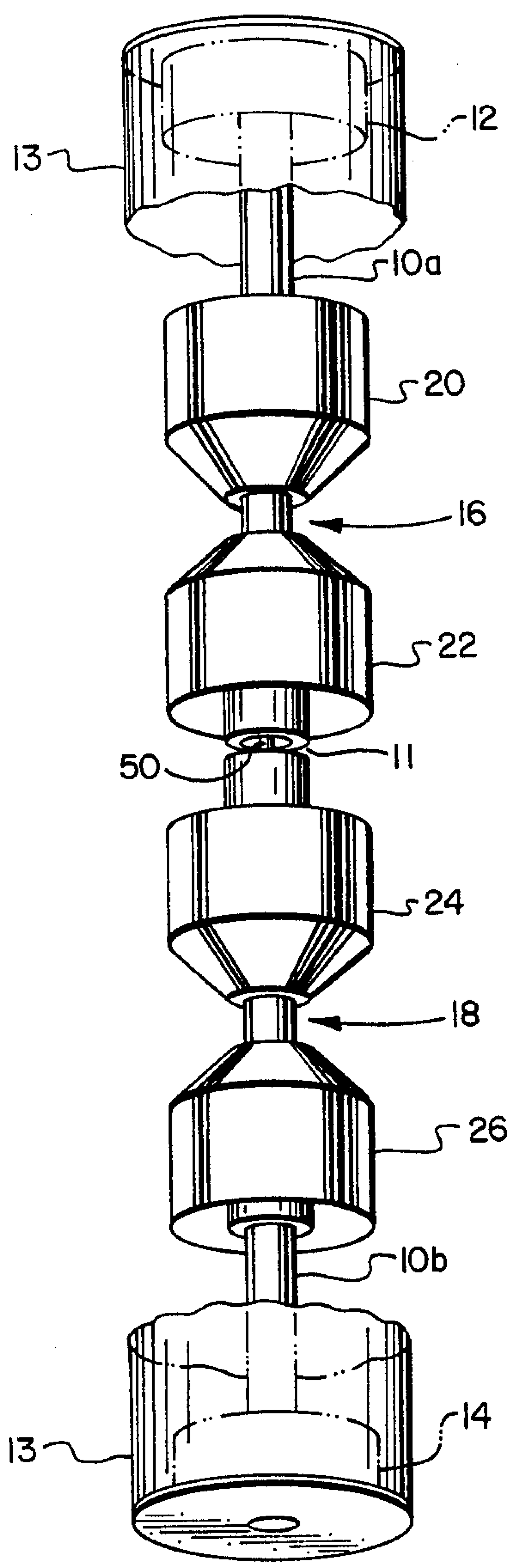
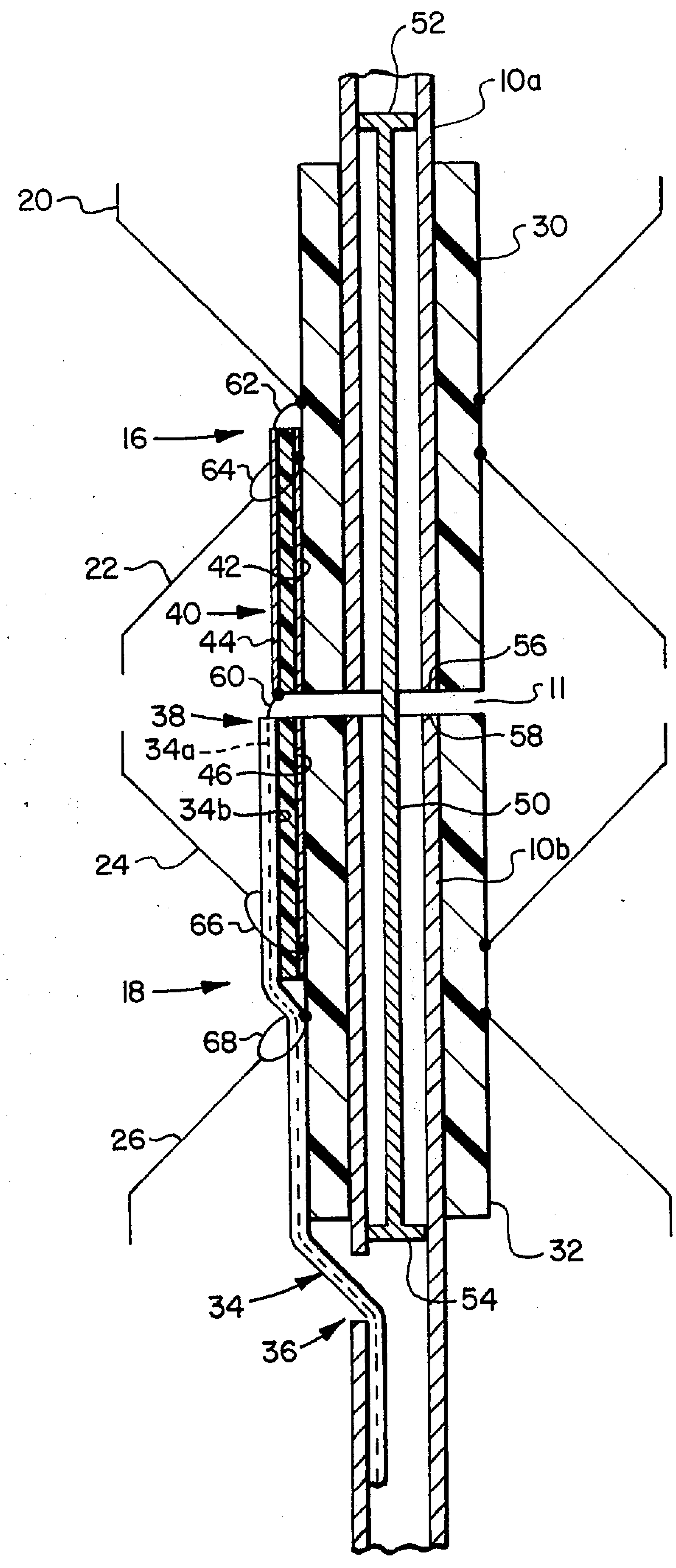

13
12
10a
20
16
22
50
11
24
18
26
10b
13
14

FIG. 1


52
10a
20
30
62
16
64
22
42
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44
56
60
11
38
58
34a
46
34b
50
10b
24
66
18
68
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36

FIG. 2

DUAL BAND COLLINEAR DIPOLE ANTENNA

TECHNICAL FIELD

The invention relates to electromagnetic radiating antennas, and more particularly to a dipole antenna radiating different frequency bands from a single feed source without altering the antenna.

SUMMARY AND SUMMARY

The present invention provides a simple and efficient conversion of the collinear dipole antenna disclosed in my U.S. Pat. No. 3,727,231 into a dual band antenna.

A need for a dual band implementation has arisen in one exemplary application in conjunction with military use wherein one armed forces branch uses a given band for communication and another branch uses a different band for communication, and cooperative maneuvers require intercommunication between the branches. For example, one antenna designed in accordance with my previous said patent operates in the 225–400 MHz range. Another band used by a different service branch is 108–152 MHz. One way of achieving intercommunication is by merely installing a second antenna suited for the second frequency band. It is desirable to avoid the inefficiency of two separate antennas, and instead use a dual band antenna which is capable of radiating each band.

Various dual band antennas are known. These antennas typically have two input feeds and use high patch and low patch filters for separating the two bands.

The present invention enables an extremely simple modification of an existing antenna to afford dual band operation. The antenna requires no filtering, and uses a single input. The antenna radiates a high band frequency f, and without modification radiates a low band frequency $\frac{1}{2}$ f when the latter is fed thereto. The configuration of the antenna enables it to operate as a dual dipole array at the high band frequency f, and to operate as a single dipole array at the low band frequency $\frac{1}{2}$ f.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view like that in my said U.S. Pat. No. 3,727,231, and shows a collinear dipole antenna in accordance with the present invention.

FIG. **2** is a schematic view like that in my said U.S. Pat. No. 3,727,231, and shows the antenna of FIG. **1** in section, illustrating the feed system and effective transmission line system between the gapped sections.

DETAILED DESCRIPTION

Like reference characters are used from my said U.S. Pat. No. 3,727,231 where appropriate to facilitate understanding, which patent is incorporated herein by reference.

The central hollow mast **10** of said patent is split into upper and lower sections **10***a* and **10***b* by a transverse annular gap **11**, FIG. **1**. This mast is provided with support members **12** and **14** at either end which receive cylindrical housing member **13**, shown broken away, such as a fiberglass radome, which secures the mast sections **10***a* and **10***b* in spaced facing collinear relation. Mounted collinearly on respective mast sections are two bicone dipoles **16** and **18**. Conical elements **20** and **22** are insulatively mounted on mast section **10***a* and comprise bicone **16**; similarly, conical elements **24** and **26** are insulatively mounted on mast section **10***b* and comprise bicone **18**. The bicones function as radiating dipoles at a high band frequency f in which the radiation pattern is omnidirectional towards the horizon, as in said patent.

Further as in said patent, the two biconical arrays **16** and **18** are insulatively mounted on mast **10** by insulators **30** and **32**, FIG. **2**, which function as quarterwise chokes at the center frequency of the high band. Coaxial feed line **34** which is preferably situated within mast **10** is passed externally at point **36** and terminates at a point **38** equidistant between bicones **16** and **18**. Extending from point **38** to the input of bicone **16** is a stripline **40** including base plane **42** and top conductor **44**. The inner conductor **34***a* of coaxial line **34** is ohmically connected to the top conductor **44** which in turn is ohmically connected to the upper cone **20** of bicone **16**. Ground plane **42** is ohmically connected to the bottom cone **22**. Extending from point **38** downwardly to bicone **18** is a conductor **46** which cooperatively functions with the other conductor **34***b* of coaxial line **34** as a second stripline. Conductor **46** is ohmically connected to upper cone **24** of bicone **18**, and the outer conductor **34***b* of coaxial line **34** is ohmically connected to the bottom cone **26** of bicone **18**.

The present invention splits the support means or mast **10** into two sections by means of gap **11**. The invention further provides an effective transmission line between the upper and lower mast sections by means of central bridging conductor **50** extending in spaced parallel relation within the mast. Conductor **50** spans gap **11** and extends a predetermined depth into each mast section **10***a* and **10***b*. Conductor **50** ohmically engages the inner wall of the mast at top and bottom conductor ends **52** and **54**. The predetermined depth that central conductor **50** extends into each mast section is equal to a half wavelength path at the high band frequency f. For example, if the high frequency band is 225–400 MHz, and taking the center frequency as roughly 300 MHz, then a half wavelength at 300 MHz is about 50 centimeters. The distance from top end **52** to mast edge **56** is thus about 50 centimeters in this example.

As above noted, coaxial cable **34** terminates at point **38** midway between dipoles **16** and **18**. This midway feed point **38** is adjacent gap **11** such that signal potential at feed point **38** sees the same distance to each of ends **52** and **54**. Central conductor **50** and mast section **10***a* form an effective transmission line as seen from feed point **38**. In accordance with well known transmission line principles, a half wavelength path down a transmission line appears as a low impedance short circuit path, i.e., point **52** appears shorted to mast edge **56** at about zero impedance. Likewise, bottom end **54** appears shorted to mast edge **58** at about zero impedance. Since feed point **38** sees equal low impedances at points **56** and **58**, there is effective continuity along mast sections **10***a* and **10***b* across gap **11** at the high band frequency.

The dividing of the mast into two sections **10***a* and **10***b* would normally prevent the high band from functioning properly since its stripline feed system requires RF continuity at the center point. The half wavelength path provided by transmission line means **50** at the high band frequency makes the mast appear as being continuous. It is to be noted that a half wavelength path includes all integral multiples of $\frac{1}{2}\lambda$, i.e., λ, $3/2\ \lambda$, $2\ \lambda$, $5/2\ \lambda$, etc., and this is the meaning of half wavelength path as used herein.

In high band operation, inner conductor **34***a* of the coaxial cable, for example having a positive signal, conducts a positive charge to conductor **44** by means of ohmic connection **60**. Conductor **44** conducts this positive charge to the upper element **20** of dipole **16** by means of ohmic connection **62**. Conductor **44** induces or field couples a negative charge on reference plan conductor **42** on the other side of stripline means **40**. Conductor reference plane **42** conducts this negative charge to the bottom element **22** of dipole **16** by means of ohmic connection **64**. Dipole **16** thus radiates a field from positive element **20** out into space which is returned and referenced to negative element **22**.

The negative outer conductor **34***b* of coaxial cable **34** induces or field couples a positive charge on conductor reference plane **46** on the other side of the lower stripline means. Conductor reference plane **46** conducts this positive charge by means of ohmic connection **66** to the upper element **24** of dipole **18**. Outer conductor **34***b* of the coaxial cable is ohmically connected by means of connection **68** to the lower element **26** of dipole **18**. Dipole **18** thus radiates a field from positive plate **24** out into space which is returned and referenced to negative plate **26**. Since feed point **38** is midway between the dipoles, the dipoles radiate in phase because of the equal travel lengths thereto from the feedpoint, and because of the polarities, i.e., upper plates **20** and **24** are both positive, for example. At the high band frequency f, the antenna thus operates as a dual dipole array with each dipole **16** and **18** radiating a field.

In order for field coupling to occur and the noted charge to be induced on reference planes **42** and **46**, there must be a continuous ground return reference plane provided by mast **10**. That is, there must be, or appear to be, continuity across mast sections **10***a* and **10***b*. This continuity is effectively provided by transmission line means **50** at the high frequency band.

The distance between points **56** and **52**, and between points **58** and **54**, determine continuity across mast sections **10***a* and **10***b* relative to the frequency band. As noted, the distance from point **52** to point **56** is a half wavelength path at a high band frequency f. This same spacial distance from point **52** to **56** is a quarter wavelength path at a frequency $\frac{1}{2}$ f. In accordance with known transmission line principles, a quarter wavelength path appears as a high impedance open circuit. Thus, at a low band frequency $\frac{1}{2}$ f, feed point **38** sees a high impedance or open circuit when looking into each of the upper and lower mast sections from gap **11**. That is, the signal from feed point **38** sees a high impedance or open circuit at each of points **56** and **58**, and thus there is discontinuity between mast sections **10***a* and **10***b*. The high impedance open circuit along a transmission line appears at all odd multiples of $\frac{1}{4}\lambda$, i.e., at $\frac{1}{4}\lambda$, $\frac{3}{4}\lambda$, $5/4\ \lambda$, $7/4\ \lambda$, etc., and this is the meaning used herein for quarter wavelength path.

In low band operation at frequency $\frac{1}{2}$ f, there is discontinuity between the upper and lower mast sections **10***a* and **10***b*. Because of this discontinuity, there is no common continuous ground return reference plane for the conductor reference planes **42** and **46**. Thus, there is no field coupling or charge induced on these latter, and instead the charge from midpoint **38** accumulates at the facing edges **56** and **58** of the mast sections across gap **11**. This accumulation of charge causes each mast section to operate as half of a single dipole, rather than as a dual dipole array. Upper mast section **10***a* and all of its parts are half of the new single dipole array, and lower mast section **10***b* and all of its parts are the other half of the now single dipole array. Upper mast section **10***a*, dipole **16** and member **12** radiate a field out into space which is returned and referenced to the other half of the single dipole array which is lower mast section **10***b*, dipole **18** and member **14**.

It is thus seen that at the high band frequency f, there is apparent continuity across gap **11** along mast sections **10***a* and **10***b*, and the antenna operates as a dual dipole array with each dipole **16** and **18** radiating a field. At the low band frequency $\frac{1}{2}$ f, there is discontinuity between the mast sections, and the antenna operates as a single dipole array with each mast section and its respective dipole acting as half of the single dipole array.

It is recognized that various modifications are possible within the scope of the appended claims.

I claim:

1. A dual band dipole antenna comprising:
support means with spaced first and second sections;
a pair of dipoles mounted on respective said first and second support means sections;
feed means for energizing said dipoles; and
transmission line means between said first and second support means sections providing a low impedance path for continuity therebetween at a high band frequency f, and providing a high impedance path for discontinuity therebetween at a low band frequency $\frac{1}{2}$ f,
such that at the high band frequency f, said antenna operates as a dual dipole array,
and such that at the low band frequency $\frac{1}{2}$ f, said antenna operates as a single dipole array with each support means section and its respective dipole acting as half of the single dipole array.

2. The invention according to claim **1** wherein said transmission line means provides a low impedance short circuit half wavelength path from said feed means at said high band frequency f, and provides a high impedance open circuit quarter wavelength path from said feed means at said low band frequency $\frac{1}{2}$ f.

3. The invention according to claim **2** wherein:
said transmission line means comprises a bridging conductor extending in spaced parallel relation with said support means sections and ohmically connected to each at a predetermined distance from the facing ends thereof, said predetermined distance equal to said half wavelength path at said high band frequency f.

4. The invention according to claim **2** wherein:
said support means comprises a hollow cylindrical mast having an annular gap splitting the mast into first and second facing collinear sections; and
said transmission line means comprises a central conductor within said mast spanning said gap and extending into each section in spaced parallel relation therewith, and including means ohmically connecting said central conductor to the inner wall of said mast at a predetermined depth equal to said half wavelength of said high band frequency f.

5. A dual band collinear dipole antenna comprising:
a hollow cylindrical vertical support mast having a transverse annular gap spliting the mast into upper and lower sections;
a central vertical conductor extending in spaced parallel relation within said mast spanning said gap and extending a predetermined depth into each section, said central conductor having top and

bottom ends ohmically engaging the inner wall of said mast;

upper and lower dipoles mounted on respective said upper and lower mast sections;

coaxial feed means supplying said dipoles in phase from a feedpoint midway therebetween adjacent said gap;

said central conductor forming a transmission line with the inner wall of said mast from said feedpoint to each said top and bottom end, said predetermined depth equal to a half wavelength path at a high band frequency f, and equal to a quarter wavelength path at a low band frequency ½ f;

such that at the high band frequency f, there appears to be continuity between said mast sections across said gap such that said mast appears as a continuous ground return reference and each said dipole radiates a field, whereby said antenna operates as a dual dipole array;

and such that at the low band frequency ½ f, there is discontinuity between said mast sections such that one mast section and its respective said dipole is the reference for the other mast section and its respective said dipole, whereby said antenna operates as a single dipole array with a field radiated from one mast section and its respective said dipole as half of the single dipole array and returned and referenced to the other mast section and its respective said dipole as the other half of the single dipole array.

6. A dual band collinear dipole antenna comprising:

a two piece support mast having spaced upper and lower collinear sections;

two dipoles insulatively mounted collinearly on respective said mast sections;

lower stripline means comprising a reference plane extending from a feedpoint midway between said dipoles to the lower said dipole;

upper stripline means comprising a reference plane and a conductor extending from said feedpoint to the upper said dipole;

coaxial feed means extending parallel to said lower stripline means and termininating at said feedpoint, the outer conductor of said coaxial feed means interacting with said reference plane of said lower stripline means for field coupling therewith;

means ohmically connecting the inner conductor of said coaxial feed means to said conductor of said upper stripline means;

means ohmically connecting said conductor of said upper stripline means to one element of said upper dipole;

means ohmically connecting said reference plane of said upper stripline means to the other element of said upper dipole;

means ohmically connecting said reference plane of said lower stripline means to one element of said lower dipole;

means ohmically connecting said outer conductor of said coaxial feed means to the other element of said lower dipole; and

transmission line means between said upper and lower mast sections providing a low impedance path for continuity therebetween at a high band frequency f, and providing a high impedance path for discontinuity therebetween at a low band frequency ½ f, such that at the high band frequency f said antenna operates as a dual dipole array with each dipole radiating in phase, and such that at the low band frequency ½ f said antenna operates as a single dipole array with each mast section and its respective dipole acting as half of the single dipole array.

7. The invention according to claim **6** wherein:

said transmission line means comprises a briding conductor extending in spaced parallel relation with said mast sections and ohmically connected to each at a predetermined distance from said feedpoint;

said feedpoint is adjacent the facing ends of said mast sections;

said predetermined distance equals a half wavelength path at said high band frequency f;

such that at said high band frequency f, there appears to be continuity between said mast sections such that said mast appears as a continuous ground return reference for both said reference planes of said lower and upper stripline means, and each said dipole radiates a field, whereby said antenna operates as a dual dipole array;

and such that at said low band frequency ½ f, there is discontinuity between said mast sections and no common continuous ground return reference for said reference planes of said lower and upper stripline means, such that one mast section and its respective said dipole is the reference for the other mast section and its respective said dipole, whereby said antenna operates as a single dipole array with a field radiated from one mast section and its respective said dipole as half of the single dipole array and returned and referenced to the other mast section and its respective said dipole as the other half of the single dipole array.

8. The invention according to claim **7** wherein:

said support mast comprises a hollow cylindrical mast having a transverse annular gap splitting the mast into said upper and lower sections; and

said transmission line means bridging conductor comprises a central conductor in spaced parallel relation within said mast spanning said gap, with top and bottom ends ohmically engaging the inner walls of said mast.

* * * * *